

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

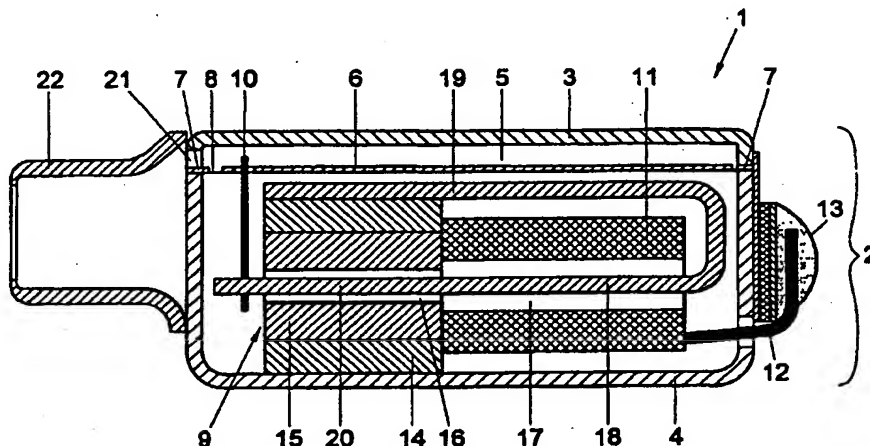
**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> : <b>H04R 25/00</b>	<b>A1</b>	(11) International Publication Number: <b>WO 00/60902</b> (43) International Publication Date: <b>12 October 2000 (12.10.00)</b>
<p>(21) International Application Number: <b>PCT/NL00/00223</b></p> <p>(22) International Filing Date: <b>5 April 2000 (05.04.00)</b></p> <p>(30) Priority Data: <b>1011733</b>      <b>6 April 1999 (06.04.99)</b>      <b>NL</b></p> <p>(71) Applicant (for all designated States except US): <b>MI-CROTRONIC NEDERLAND B.V. [NL/NL]; Zeker- ingstraat 9, NL-1014 BM Amsterdam (NL).</b></p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): <b>WILMINK, Engbert [NL/NL]; Giststraat 16, NL-2611 PT Delft (NL). VAN HALTEREN, Aart, Zeger [NL/NL]; Oud Raeffeldamweg 2, NL-1447 EG Hobrede (NL). DOLLEMAN, Hendrik [NL/NL]; Franciscanenstraat 10, NL-1566 LD Assendelft (NL). VAN HAL, Paul, Christiaan [NL/NL]; Cole Porterhof 61, NL-1628 TJ Hoorl (NL).</b></p> <p>(74) Agent: <b>PRINS, A., W.; Vereenigde, Nieuwe Parklaan 97, NL-2582 BN The Hague (NL).</b></p>	<p>(81) Designated States: <b>JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</b></p> <p><b>Published</b> <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Dutch).</i></p>	

(54) Title: **ELECTROACOUSTIC TRANSDUCER WITH A DIAPHRAGM, AND METHOD FOR FIXING A DIAPHRAGM IN SUCH TRANSDUCER**



## (57) Abstract

A method for manufacturing an electroacoustic transducer for, for instance, a hearing aid, with a diaphragm (5) arranged in a housing (2). According to the invention, the diaphragm is attached onto a film or punched from a sheet of material, such that along the circumferential edge of the diaphragm, a free strip of film or a strip of material (7) remains present. In a capillary space between the circumferential edge of the film and the inner wall of the housing, or in a capillary space (8) between the diaphragm and the strip of material, a polymer of a low viscosity is provided to connect the diaphragm with the housing wall. Through the method, the production of the transducer is greatly simplified.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

**Title:** Electroacoustic transducer with a diaphragm, and method for fixing a diaphragm in such transducer.

The invention relates to an electroacoustic transducer, comprising:  
a case; a diaphragm disposed in the case, comprising a central diaphragm portion and an edge portion extending therearound; means for, respectively, converting an electric signal to a vibration of the central  
5 diaphragm portion, or converting a vibration of the central diaphragm portion to an electric signal; while the edge portion of the diaphragm is connected to a wall portion of the case.

Such a transducer is known from NL-A-1004877 and finds application especially in hearing aids.

10 For the proper functioning of such a transducer, various requirements are imposed on the construction of inter alia the diaphragm. On the one hand, the diaphragm must be able to move freely, on the other hand it is, of course, necessary to secure the diaphragm somehow. It is therefore customary to attach the diaphragm by its circumferential edge to a support frame or to the  
15 case, whereby the central portion of the diaphragm remains unattached in order to be able to vibrate. Often, between this central diaphragm portion and the edge portion, a transition portion formed as a groove or bellows is included to give the central diaphragm portion as much freedom of vibration as possible.

20 From NL-A-1004877, it is also known to attach the diaphragm to a film, which film is attached to the case. To this end, the film is folded to enable free movement of the diaphragm. A complete suspension of the diaphragm is necessary to obtain a proper acoustic separation between the volume in the transducer above and under the diaphragm.

25 As already mentioned, an acoustic transducer is applied in, for instance, hearing aids, intended to be positioned in the exterior auditory canal of a person. Hence, there is, within this technical field, a continuous pursuit of

ever increasing miniaturization, demanding a great sensitivity of the various applied parts.

Apart from this pursuit of miniaturization, it is desired to enlarge the volume displacement by the diaphragm as much as possible, to which end it is  
5 desired that the central diaphragm portion be as large as possible. Additionally, it is desired to keep the costs of manufacturing the construction of the diaphragm as low as possible by applying as few parts as possible.

A drawback of all hitherto proposed manners of connecting a diaphragm to the case is the necessity of different production steps, each involving the  
10 possible occurrence of errors, which sometimes can and sometimes cannot be corrected, but always entail additional activities and hence additional costs.

The object of the invention is to provide a transducer of the present type and a method for the production thereof, in which these drawbacks do not occur. To this end, in a first exemplary embodiment, the invention is  
15 characterized in that the diaphragm is provided on a film, in such a manner that along at least a part of the circumferential edge of the diaphragm a free strip of film is present, and that between the circumferential edge of the film and the inner case wall a capillary space is present in which a polymer is provided as a connection between the circumferential edge and the inner case  
20 wall.

The invention also provides a method for fitting a diaphragm in a case of a transducer of the above-described type, characterized in that the diaphragm is attached to a film, in such a manner that along the circumferential edge of the diaphragm a free strip of film remains present and  
25 that in a capillary space between the circumferential edge of the film and the inner case wall a polymer of low viscosity is provided to connect the film edge to the case wall.

This embodiment of the invention has the advantage that the connection between the case and the diaphragm can be very elastic and  
30 therefore does not deform or tear even in the case of extensive deflections.

Also, the attachment is completely free of tension, which is very favorable to the acoustic properties of the diaphragm.

The polymer used should in any case have the property that it does not evaporate, does not influence the frequency response of the diaphragm, and is also able to resist particular strains. Polymers meeting these requirements are, for instance, polybutenes of different viscosities.

A second embodiment of the invention is characterized in that the diaphragm comprises a central portion and a circumferential edge located in the same plane, spaced apart from the outer edge of the central portion, the central portion and the circumferential edge being made from the same material and being connected to each other by at least one strip likewise consisting of this same material, and that between the circumferential edge of the diaphragm and the outer edge a capillary space is present in which a polymer is provided as a connection.

Additionally, the invention further provides a method characterized in that a diaphragm is formed from a sheet-like material, having a central portion and a circumferential edge located at a capillary distance from the central portion, while between the central portion and the circumferential edge at least one connecting strip is present and that in the capillary space between the central portion and the circumferential edge a flexible polymer is provided.

This second embodiment has the further advantage that the number of process steps is reduced; that errors can more easily be corrected, in particular before the polymer is provided, and that the diaphragm is suspended very flexibly from the circumferential edge, which is connected to the case, so that forming the suspension, as when a film is used, is no longer necessary. Furthermore, in this embodiment, the diaphragms can be manufactured inexpensively in mass production by means of punching. Automatic assembly of the diaphragms is equally possible.

The invention will be further elucidated below on the basis of an exemplary embodiment with reference to the drawings. In the drawings:

Fig. 1 is a cross-sectional elevation of a transducer with a diaphragm; and

5 Fig. 2 is a perspective view of a diaphragm according to the invention.

The present invention will be briefly explained with reference to Fig. 1, showing a known electroacoustic transducer 1.

The electroacoustic transducer 1 comprises a case 2 consisting of two parts, namely a first case part 3 and a second case part 4. The case 2 is  
10 generally shaped as a rectangular box, and the two case parts 3 and 4 generally have a substantially U-shaped cross section, the concave sides of the case parts 3 and 4 facing one another and, when assembled, enclosing the interior of the case 2. In the following, the first case part 3 will also be designated by the term "lid" and the second case part 4 will also be designated  
15 by the term "dish".

In the interior of the case 2 a diaphragm 5 is positioned. The diaphragm 5 has a central diaphragm portion 6, and an edge portion 7 extending therearound, intended for fixing the diaphragm 5 to the case 2. Between the central diaphragm portion 6 and the edge portion 7, the diaphragm 5 has a  
20 transition portion 8, which may be shaped as a pattern of folds.

Mounted on the dish 4 is an actuator 9, which is coupled by means of a movement transmission member 10, hereinafter referred to as "fork", to the central diaphragm portion 6.

Since the nature and construction of the actuator 9 are no subject  
25 matter of the present invention, and the skilled person does not need any knowledge thereof for a proper understanding of the present invention, while moreover use can be made of an actuator known per se, these aspects will only be described briefly. The actuator 9 comprises an electric coil 11 being connected by means of an electric wire 12 extending through the dish 4, to  
30 terminals 13 mounted on the outer surface of the case 2. In a magnet housing

14 a magnetic element 15 is arranged. An air gap 16 of the magnetic element 15 is aligned with an air gap 17 of the coil 11. A U-shaped armature 18 has a first leg 19 being connected to the magnet housing 14 and a second leg 20 extending in the air gaps 16 and 17 which are in alignment with each other.

5 Connected to the end of the second armature leg 20 is the fork 10.

When an externally generated current is presented to the coil 11, a force is applied to the armature 18 by an interaction between the fields generated by the magnetic element 15 and the coil 11. Thus, a displacement is generated in the longitudinal direction of the fork causing the diaphragm to vibrate in  
10 order to generate a pressure wave.

The lid 3 has an opening 21, through which the interior of the case 2, located between the lid 3 and the diaphragm 5, communicates with the exterior world. Connected to the case is a substantially cylindrical snout 22, to which, if so desired, a flexible tube can be connected for conducting pressure  
15 waves.

As is shown in Fig. 1, in the electroacoustic transducer 1, the edge portion 7 of the diaphragm 5 is positioned in a plane parallel to the plane defined by the central diaphragm portion 6.

The edge portion 7 of the diaphragm 5 is fixed, for instance by way of  
20 gluing, to the free end edges of the side walls of the dish 4. These free end edges define a surface which is suitable for attaching the edge portion 7 of the diaphragm 5, and whose width is defined by the thickness of the side walls of the dish 4. Such method of connecting the diaphragm is known from NL-A-1004877.

25 According to the invention, a flexible polymer can be provided in a capillary space between the edge portion or the circumferential edge 7 of the diaphragm 5 and the inner wall of the case 4 to attach the circumferential edge 7 and thus the diaphragm 5 to the dish 4 of the case.

In the first embodiment of the invention, the central diaphragm portion  
30 6 is attached to a film and a polymer is provided in a capillary space between



the outer edge of the film and the case wall. This embodiment is not shown in the drawing, since the construction is virtually the same as that in the construction in Fig. 1, the only difference being that there is no diaphragm portion between the lid and the dish of the transducer case.

- 5                    Fig. 2 schematically shows a diaphragm according to a second embodiment of the invention, such as it can be applied in the transducer according to Fig. 1. The central diaphragm portion 6 and the circumferential edge 7 are connected to one another by means of one or more connecting strips or bridges 23. The diaphragm 5 can be simply punched out of a sheet of
- 10    material, for instance aluminum. The central portion is freely movable relative to the circumferential edge. In the capillary interspace 8 the flexible polymer is provided. In this embodiment, the diaphragm can, if so desired, be connected with its edge portion between the free end edges of the lid 3 and dish 4.

CLAIMS

1. An electroacoustic transducer (1), comprising:  
a case (2);  
a diaphragm (5) disposed in the case (2), comprising a central  
diaphragm portion (6) and an edge portion (7) extending therearound;  
5 means (8, 9) for, respectively, converting an electric signal to a vibration  
of the central diaphragm portion (6), or converting a vibration of the central  
diaphragm portion (6) to an electric signal, while the edge portion (7) of the  
diaphragm (5) is connected to a wall portion of the case (2);  
characterized in that the diaphragm is provided on a film, such that  
10 along at least a part of the circumferential edge of the diaphragm a free strip  
of film is present, and that between the circumferential edge of the film and  
the inner wall of the case a capillary space is present, in which a polymer is  
provided as a connection between the circumferential edge and the inner wall  
of the case.  
15
2. An electroacoustic transducer (1), comprising:  
a case (2);  
a diaphragm (5) disposed in the case (2), comprising a central  
diaphragm portion (6) and an edge portion (7) extending therearound;  
20 means (8, 9) for, respectively, converting an electric signal to a vibration  
of the central diaphragm portion (6), or converting a vibration of the central  
diaphragm portion (6) to an electric signal, while the edge portion (7) of the  
diaphragm (5) is connected to a wall portion of the case (2);  
characterized in that the diaphragm comprises a central portion and a  
25 circumferential edge, located in the same plane, spaced apart from the outer  
edge of the central portion, the central portion and the circumferential edge  
consisting of the same material and being connected to each other via at least

one strip also consisting of this material, and that between the circumferential edge of the diaphragm and the outer edge a capillary space is present in which a polymer is provided as a connection between the circumferential edge and the outer edge.

5

3. A method for manufacturing a transducer according to claim 1, characterized in that the diaphragm is attached onto a film, such that along the circumferential edge of the diaphragm a free strip of film remains present and that in a capillary space between the circumferential edge of the film and the inner case wall a polymer of low viscosity is provided to connect the edge of the film with the case wall.

10

4. A method for manufacturing a transducer according to claim 2, characterized in that a diaphragm is formed from a sheetlike material, said diaphragm having a central portion and a circumferential edge spaced apart from the central portion, while between the central portion and the circumferential edge at least one connecting strip remains present and that in a capillary space between the central portion and the circumferential edge a flexible polymer is provided.

15

20

5. A method according to claim 3 or 4, characterized in that, as polymer, polybutene is used.

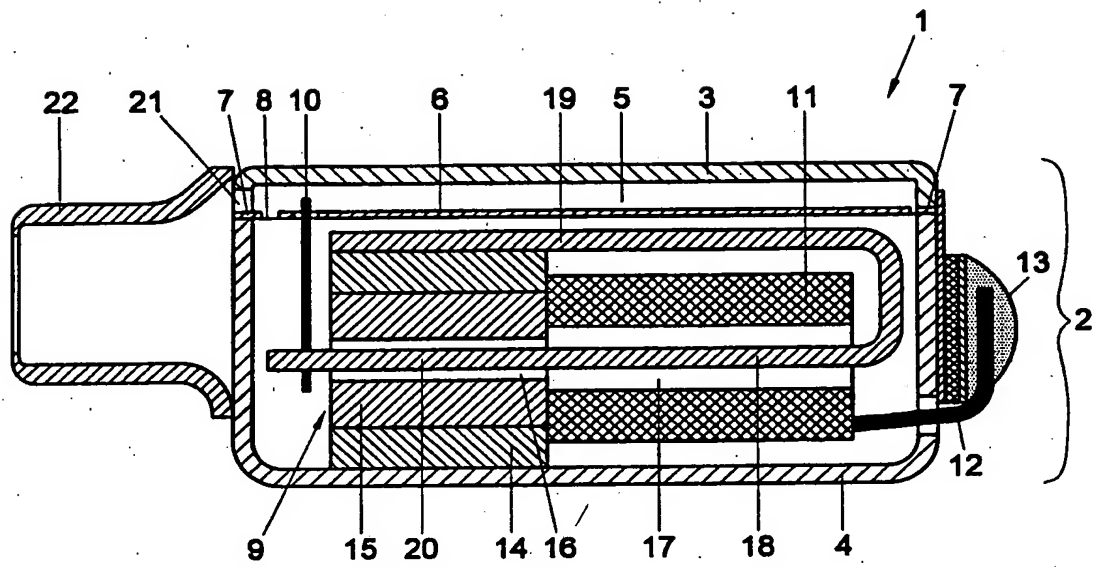


Fig. 1

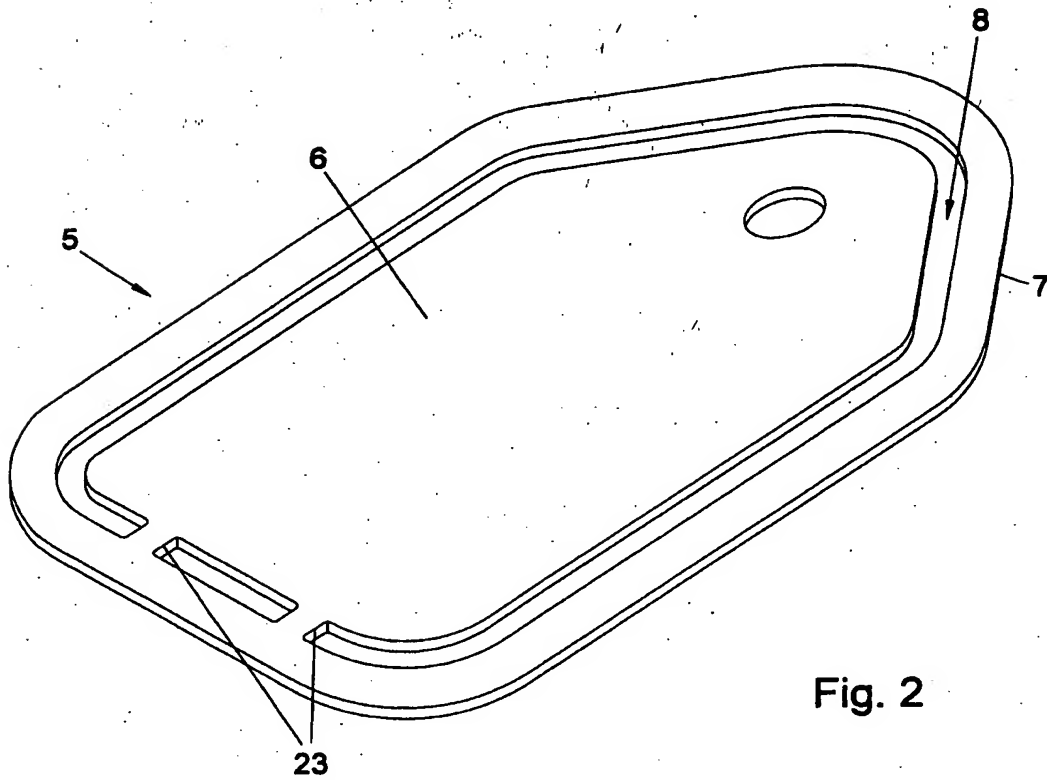


Fig. 2

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/NL 00/00223

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 H04R25/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 354 698 A (MINNESOTA MINING & MFG) 14 February 1990 (1990-02-14) column 3, line 27 -column 6, line 3 abstract	1-5
X	GB 2 229 339 A (MICROTEL BV) 19 September 1990 (1990-09-19) page 1, line 1 -page 2, line 25 claims 1-7; figures 3,4	1-4
A	EP 0 851 710 A (MICROTRONIC NEDERLAND BV) 1 July 1998 (1998-07-01) the whole document	1-4

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

13 September 2000

Date of mailing of the international search report

19/09/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Coppieters, S

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/NL 00/00223

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0354698 A	14-02-1990	US 4969534 A	13-11-1990
		AT 114393 T	15-12-1994
		AU 613219 B	25-07-1991
		AU 3903989 A	08-02-1990
		BR 8903935 A	20-03-1990
		CA 1326831 A	08-02-1994
		DE 68919452 D	05-01-1995
		DE 68919452 T	18-05-1995
		DK 384689 A	09-02-1990
		JP 2090800 A	30-03-1990
		JP 2763926 B	11-06-1998
		KR 9707298 B	07-05-1997
GB 2229339 A	19-09-1990	NL 8900613 A	01-10-1990
		JP 2274200 A	08-11-1990
EP 0851710 A	01-07-1998	NL 1004877 C	03-08-1998
		NL 1004877 A	25-06-1998
		US 6078677 A	20-06-2000